Description Document

ESPRIT
Scenario Planner Functional Capabilities

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1 Introduction

This document provides a summary and discussions of the Scenario Planner's functional capabilities. These capabilities are grouped according to their role in scenario pre-planning, planning, execution, and event monitoring. Section 5 discusses additional Scenario Planner features that have been identified that will greatly enhance its utility or were not completed in the current version due to funding cuts and shortfalls.

2 Scenario Pre-Planning

Scenario pre-planning refers to those sets of user actions to enter sensor and vehicle models, sensor entities, vehicle trajectory data sets, and overlays. Scenario pre-planning establishes the building blocks used for subsequent scenario planning.

2.1 Sensor Model Entry

Through application of a data entry panel, the operator can enter model parameters and name a sensor model. The sensor model contains data necessary to mimic the sensor's detection characteristics and calculate a signal-to-noise (S/N) statistic against a given target. Supported sensor model types include active sensors (tracking and surveillance) and receiver only (Global Positioning System [GPS] and telemetry). After entry, a sensor model may be selected, edited, copied to a file of a different name, or deleted.

2.2 Vehicle Model Entry

Through application of a data entry panel, the operator can enter model parameters and name a vehicle model. The vehicle model contains data necessary to constrain the vehicle performance during scenario planning so that the scripted vehicle behavior can be simulated realistically during scenario planning. After entry, a vehicle model may be selected, edited, copied to a file of a different name, or deleted.

2.3 Sensor Entity Entry

The Scenario Planner supports Sensor Entity creation. A sensor entity is a single instance of a sensor model with a precise location and call sign or name. Multiple sensor entities can be created from a single sensor model. A mobile sensor entity is created by defining its location on a specified vehicle. After entry, a sensor entity may be selected, edited, copied to a file of a different name, or deleted.

2.4 Vehicle Entity Entry

Although considered early in the Scenario Planner's evolution, vehicle entity definition as a phase of pre-planning was never elaborated. Vehicle entity definition, instead, is

accomplished during scenario planning by selecting the appropriate vehicle model and defining the vehicle's behavior.

2.5 Data Set Entry

Outputs from external modeling software can be imported directly into the Scenario Planner for subsequent incorporation into scenario plans. Currently provided data sets have come exclusively from the Trajectory Analysis and Optimization Software (TAOS) and have been used to describe the trajectories of only tactical ballistic missiles (TBMs). Application of this capability to other vehicle types has been demonstrated.

Imported models are modified and saved as new data sets by translation of the origin and rotation of the trajectory.

2.6 Data Set Creation

The TAOS is integrated into the Scenario Planner so that the user can request trajectory specification for a given vehicle type by entering specific pre-launch parameters. The number of supported vehicles will grow as model specification parameters for additional vehicles become available.

2.7 Overlay Generation

The Scenario Planner has a complete set of drawing tools that allow the generation of graphical overlays for definition of debris hazard areas, planned intercept areas, keep-out zones, etc. The drawing tool allows precise location of overlay points and vertices, and exact specification of angles. Additionally, overlays can be freely rotated or moved to alternative locations.

Complex overlays can be generated by the grouping of several simpler overlays.

Once generated, overlays can be selected, edited, renamed, or deleted.

The overlay generation capability includes the ability to translate Range-developed graphical overlay group (GOG) files to and from Scenario Planner overlay files.

3 Scenario Planning

Scenario planning uses the models, entities, data sets, and overlays defined during pre-planning to script vehicle behavior, assign sensor tracking responsibilities, incorporate overlays, and generate the event timeline by synchronizing vehicle trajectories.

3.1 Vehicle Entity Assignment

Vehicle entities are created and entered into a scenario by selection of the appropriate vehicle model or data set and assigning a Vehicle ID (VID). The vehicle trajectory is

predefined for data set entities. Other vehicle trajectories are specified by the entry and modification of waypoints.

Waypoint trajectory specification allows precise definition of the vehicle path through entry of position, speed, maneuver characteristics, and dive/climb characteristics. These parameters default to model nominal values and are constrained by model maximum and minimum values. Waypoint entry can proceed in either a forward or backward direction of motion. Additionally, waypoints can be inserted between a predecessor and successor waypoint. Waypoints can be selected and edited or deleted.

3.2 Sensor Entity Assignment

Sensor entities can be assigned to a scenario by simple selection and assignment of tracking responsibilities. After entry, the sensor entity can be selected, edited, or deleted.

Although not specifically identified as a Scenario Planner requirement, assignment of multiple target tracking responsibilities during different phases of a scenario has been indicated as a desirable feature. This is an area for system upgrade.

3.3 Event Timeline Synchronization

Specific points on each vehicle trajectory can be synchronized to permit expression of scenario objectives. For example, each vehicle's initial point IP position can be synchronized to each other. Additionally, a specific point on a selected vehicle's path can be assigned the time zero or T-0 designation. All synchronized trajectory times are automatically adjusted to reflect relative launch times and on-station times.

3.4 Planning Aids

Planning aids assist the planner to validate and demonstrate that the plan will achieve the stated objectives. These aids include:

a. Planning reports – - include waypoint reports and vehicle trajectory reports. These report outputs are suitable for entry into other presentation and analysis tools.

b. S/N plots - allow the user to evaluate sensor detection probability during the course of a vehicle's planned trajectory.

c. Validity checks – user waypoint entries are checked to verify that model constraints are not violated.

d. Planned path time tics and synchronization lines - assist the user to visualize relative timing objectives.

e. User-friendly planning tools - allow position entry via point and click and/or precise data entry.

f. Data readout - provides constant feedback to planner of relative pointer position.

g. Scenario playback in preview mode - allows viewing of scenario plan and evaluation of time synchronization of vehicle paths.

h. Scenario playback in local execution mode - allows multi-station rehearsal.

i. Scenario playback - allows playback at various speeds and includes controls for Start, Pause, Resume, and Stop. Scenario playback start time can be controlled by the user.

4 Scenario Execution/Event Monitoring

Scenario Execution allows the user to execute the scenario plan in preview, rehearsal, or live event monitoring modes.

4.1 Visual Aids to:

Monitor actual position to planned position and path

Overlays used to monitor safety constraints

Decision aids provided to monitor trajectory, Instantaneous Intercept Point (IIP), aspect angle, and relative Times-To-Go (TGOs)

4.2 Display Features

The Scenario Planner visualization capability is built upon the Tactical Display Framework (TDF). This is a mature and robust display capability that contains many features, including:

a. Customizable display presentation

b. Multiple view-save for rapid recall

c. Presentation of items of interest only from customizable track lists

d. Presentation of items of interest only from Customizable track tags

e. Easy controls that bring target of interest into close control

f. Fully functional map features: terrain, lakes and rivers, depth contours, sovereign territories, etc

g. Display use of the WGS 84 Earth Model

h. Orthographic, Mercator, or equidistant cylindrical map projections

i. Adjustable latitude/longitude grid lines with annotations

j. Customizable track history presentation

k. Selectable track symbol set

l. Fully adjustable color scheme

m. Ability to show range/bearing line, range circle, or range circle with compass points from reference to pointer

n. True North vs. magnetic North presentation

o. Multiple range scale adjustment capabilities

p. Multiple view offset controls

5 Identified Features for Future Implementation

The Scenario Planner has been developed based upon an extensible, object-oriented design to allow the user to model and add new sensors and vehicles to the suite of tools without writing any new software. Because of this extensible design, new features can be added with minimal effect to already implemented software features.

The scenario planning tool currently provides an excellent tool for planning complex events, including capabilities for scripting vehicle paths, definition of high-fidelity missile models, and importing externally generated high fidelity vehicle data sets.

Additionally, sensor modeling and sensor entity creation capabilities allow placement and performance modeling of all Range sensor assets, including sensors mounted on mobile platforms. Scenario definition allows sensor tracking assignment to specific vehicles and pre-event evaluation of target coverage.

Importantly, vehicle trajectory synchronization and expression of the T-0 event allows the expression of the scenario objectives and the event timeline.

Areas of additional functionality required to complete the scenario planning capability include enhanced planning documentation and reporting, additional decision aids, improved replanning capabilities, real time event synchronization, and asset control and information.

These requirements are described individually in the following paragraphs.

5.1 Enhanced Planning Documentation and Reporting

Inherent in the activity of scenario planning is the entry of a host of information, including Vehicle IDs and call signs, SIF codes, sensor tracking assignments, and pertinent timeline annotations. This information can be used to automatically generate

scenario plan reports that are currently generated manually. Automatic generation of these reports will assure consistency between the plan and the report content. The fidelity of these reports can be selected to match the needs of the recipient. Screen captures may be used to illustrate the report.

Collaborative planning is enhanced by the accuracy and timeliness of these reports, and can be extended further by electronic exchange of the actual scenario plan during developmental stages.

An added benefit is that the Scenario Planner is more fully incorporated into the planning process, encouraging increased usage.

5.2 Decision Aids

As event experience has been gained, tools to assist the Operations (Ops) Conductor monitor assets and the progression of the events have been identified and implemented within the Scenario Planner. These include hazard pattern overlays, "in-the-box" intercept point prediction and display, TGO plots, and aspect angle plots. The Ops Conductor at PMRF expressed a requirement to enhance these decision aids by providing Go/No Go matrices. These matrices are constructed during scenario planning by defining criteria to be monitored during event rehearsal and during the actual exercise. As examples, these criteria can be vehicle performance vs. nominal, sensor "on-target" status, target/vehicle absolute and relative timelines, etc. Such criteria can be categorized by decision criteria, such as "Pre-launch", and reviewed by the Ops Conductor at the appropriate decision point. This important feature will be refined as additional event experience is gained and with the increasing complexity of upcoming events.

5.3 Improved Re-Planning Capabilities

The Scenario Planner provides capabilities to easily rotate a hazard area overlay in conjunction with a modified launch angle. Flight paths scripted with waypoints must be rescripted point-by-point to achieve the same aspect to a modified target/interceptor trajectory. Currently the Scenario Planner implements a hard separation between planning and scenario execution, so replanning using the tool cannot take place while the event is underway.

Areas where replanning enhancements would greatly improve the utility of the tool are:

a. Event Driven Scenario Coordination: This concept will synchronize portions of the scenario to actual external events rather than have all vehicle trajectories tightly constrained to the original planned event timeline. Event driven scenario coordination will link the execution of related portions of the plan, to the occurrence of a discrete event such as the launch of a target missile.

b. Real Time Replanning: This will allow the operator to replan the flight path of a controlled aircraft during the event to meet critical timeline objectives. It allows hazard pattern and target path rotation while the scenario is running.

c. Contingency Replanning: This will allow the loading of preplanned contingency trajectories during the event.

5.4 Real Time Event Synchronization

Current implementation of the Scenario Planner requires all vehicle trajectories and scripted events to be tied to a single-event timeline. Actual complex events may have several independent timelines. A flexible method of implementing these timelines and allowing each to be triggered by the appropriate real time event is required.

5.5 Asset Control and Information

The Range currently has partial implementation and utilization of two software functions called the Sensor Information Table (SIT) and Vehicle Information Table (VIT). These functions, upon request, send out information to clients regarding sensor to target tracking assignments, vehicle call signs, and SIF codes. The SIT can also be used to change sensor tracking assignments during an event. Because the scenario planning tool is the repository of most of this information, it is a reasonable expectation that the scenario planning tool be charged with these two functions. Inherent in this responsibility is the generation of the original SIT and VIT based upon the plan, appropriate dissemination of the SIT and VIT, and modification of the plan in accordance with manual changes to the SIT or VIT.